# JEE MAIN 2026

## Sample Paper - 14

**Time Allowed:** 3 hours **Maximum Marks:** 300

**General Instructions:**

**1.** The test consists of total 75 questions.

**2.** Each subject (PCM) has 25 questions.

**3.** Each subject divided into two sections. Section A consists of 20 multiple-choice questions & Section B consists of 5 numerical value-type questions.

**4. Marking Scheme:**

- Section A (MCQs): +4 marks for each correct answer, -1 mark for each incorrect answer, 0 marks for unattempted.
- Section B (Numerical): +4 marks for each correct answer, 0 marks for incorrect or unattempted.

**5.** Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

**6.** All calculations/written work should be done in the rough sheet is provided with the Question Paper.

## MATHEMATICS

**Max Marks: 100**

### SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

**Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.**

**1.** Let $e$ be the eccentricity of a hyperbola and $f(e)$ be the eccentricity of its conjugate hyperbola then $\int\left(f(e)+f\left(f(e)\right)\right)de=g(e)$ and $g\left(\sqrt{2}\right)=2$, then $g(e)=$

**1)** $\frac{1}{2}\sqrt{e^2-1}+\frac{e^2}{2}$ **2)** $\frac{1}{2}\sqrt{e^2+1}+\frac{e^2}{2}$ **3)** $\sqrt{e^2-1}+\frac{e^2}{2}$ **4)** $\sqrt{e^2+1}+\frac{e^2}{2}$

**2.** The integral $\int_0^1 \frac{\tan^{-1}x}{1+x}dx$ equals

**1)** $\pi\log_e 2$ **2)** $\frac{\pi}{4}\log_e 2$ **3)** $\frac{\pi}{8}\log_e 2$ **4)** $\frac{\pi}{2}\log_e 2$

**3.** Let $z_1$ and $z_2$ be two complex number such that $|z_1|=1$ and $|z_2|=10$.

If $\theta=arg\left(\frac{z_1-z_2}{z_2}\right)$ then maximum value of $\tan^2\theta$ is

**1)** $\frac{1}{10}$ **2)** $\frac{1}{100}$ **3)** $\frac{1}{99}$ **4)** $\frac{10}{99}$

**4.** The probability that the birthdays of six different persons will fall in exactly two calendar months

**1)** $\frac{342}{12^5}$ **2)** $\frac{341}{12^6}$ **3)** $\frac{341}{12^5}$ **4)** $\frac{342}{12^6}$

**5.** The system of equations

$(1-\lambda)x+3y-4z=0$

$x-(3+\lambda)y+5z=0$

$3x+y-\lambda z=0$

possesses non-trivial solutions for

**1)** exactly three distinct real values of $\lambda$

**2)** exactly two distinct real values of $\lambda$

**3)** exactly one real values of $\lambda$

**4)** infinite number of distinct real values of $\lambda$

**6.**

| List-I | | List-II | |
|---|---|---|---|
| (A) | If the line $\frac{x-4}{1}=\frac{y-2}{1}=\frac{z-2k}{2}$ lies in the plane $2x-4y+z=3$, then k is equal to | (I) | $\frac{9}{2}$ |
| (B) | If the lines $\frac{x-1}{2}=\frac{y+1}{3}=\frac{z-1}{4}$ and $\frac{x-3}{1}=\frac{y-k}{2}=\frac{z}{1}$ intersect, then value of k is | (II) | $\frac{3}{2}$ |
| (C) | If a plane passes through the point $(1,1,1)$ cuts the coordinate axes at A, B & C respectively such that $OA=OB=OC$ where O is the origin, then volume of tetrahedron OABC is equal to | (III) | $\frac{5}{2}$ |
| (D) | If a plane $P$ passes through $(1,-2,1)$ is perpendicular to two planes $2x-2y+z=0$ and $x-y+2z=4$. The distance of plane $P$ from the point $\left(-1,\frac{5}{\sqrt{2}},\frac{3}{\sqrt{2}}\right)$ is | (IV) | $\frac{7}{2}$ |

**1)** (A) - II, (B) - I, (C) - I, (D) - III **2)** (A) - I, (B) - III, (C) - IV, (D) – II

**3)** (A) - II, (B) - II, (C) - I, (D) - III **4)** (A) - II, (B) -I , (C) - III, (D) - III

**7.** Let $\vec{a},\vec{b}$ be two non collinear unit vectors and $\vec{x}=\vec{a}-(\vec{a}\cdot\vec{b})\vec{b}$ and $\vec{y}=\vec{a}\times\vec{b}$. Now consider the following statements :

Statement-I: $|\vec{x}|=|\vec{y}|$

Statement-II : $|\vec{y}|=|\vec{x}|+|\vec{x}\cdot\vec{b}|$

**1)** Statement-I is true but Statement-II is false

**2)** Both Statement-I and Statement-II are false

**3)** Both Statement-I and Statement-II are true

**4)** Statement-I is false but Statement-II is true

**8.** The smaller area (in sq. units) included between the curves $\sqrt{x}+\sqrt{|y|}=1$ and $|x|+|y|=1$ is

**1)** $\frac{1}{3}$ **2)** $\frac{4}{3}$ **3)** $\frac{2}{3}$ **4)** $\frac{5}{3}$

**9.** Exhaustive value of $x$ such that $\cos^{-1}\left(\frac{8x}{1+16x^2}\right)=-\frac{\pi}{2}+2\tan^{-1}(4x)$

**1)** $\left(\frac{1}{8},\infty\right)$ **2)** $\left(\frac{1}{16},\frac{1}{8}\right)$ **3)** $\left[\frac{1}{4},\infty\right)$ **4)** $\left(\frac{1}{8},\frac{1}{4}\right)$

**10.** Parabola $y^2=4a(x-c_1)$ & $x^2=4a(y-c_2)$ touch each other where $c_1$ & $c_2$ are variables, then locus of their point of contact is :

**1)** $xy=a^2$ **2)** $xy=2a^2$ **3)** $xy=4a^2$ **4)** $xy=3a^2$

**11.** If A is a square matrix of order $n$ then, $\underbrace{(\text{adj adj adj adj}\ldots\text{adj A})}_{(n-1)\text{ times}}.\underbrace{(\text{adj adj adj}\ldots\text{adj A})}_{n\text{ times}}$ is equal to:

**1)** $|A^{n-1}|^{(n-1)^2}$ **2)** $|A^{-1}|^{(n-1)^{(n-1)}}$

**3)** $\frac{1}{n}|A|^{(n-1)^{(n-1)}}\cdot I_{n\times n}$ **4)** $|A|^{(n-1)^{(n-1)}}\cdot I_{n\times n}$

**12.** Two dice are thrown simultaneously to get the co-ordinates on $x-y$ plane. Then the probability that this point lies inside or on the region bounded by $|x|+|y|=3$, is:

**1)** $\frac{3}{14}$ **2)** $\frac{2}{3}$ **3)** $\frac{1}{12}$ **4)** $\frac{4}{14}$

**13.** The vector equation of the plane through the line of intersection of the planes $x+y+z=1$ and $2x+3y+4z=5$ which is perpendicular to the plane $x-y+z=0$ is :

**1)** $\vec{r}\times(\hat{i}+\hat{k})+2=0$ **2)** $\vec{r}\cdot(\hat{i}-\hat{k})-2=0$

**3)** $\vec{r}\cdot(\hat{i}-\hat{k})+2=0$ **4)** $\vec{r}\times(\hat{i}-\hat{k})+2=0$

**14.** In a survey, it was found out that 100 people don't use any of laptop, mobile or wrist watches. 80 persons use all the three gadgets. There are 150 who use laptop and mobile, 200 who use mobile and wristwatch and 200 who use laptop and wristwatch. The number of people who use only laptop, only mobile and only wristwatch is equal. If this survey was conducted on 1000 persons, how many people use only wristwatch?

**1)** 200 **2)** 170 **3)** 150 **4)** 900

**15.** Let $f(x)=\begin{cases}|1-2x^2|, & 0\le x<1\\ [x^2-2x], & 1\le x<2\end{cases}$

If m, n are number of points of discontinuity and non-differentiability of $f(x)$ in $(0, 2)$ then ([.] represents greatest integer function)

**1)** m = 1, n = 2 **2)** m = 1, n = 1 **3)** m = 2, n = 2 **4)** m=3,n=2

**16.** The area of the region between the curves $y=\sqrt{\frac{1+\sin x}{\cos x}}$ and $y=\sqrt{\frac{1-\sin x}{\cos x}}$ bounded by the lines $x=0$ and $x=\frac{\pi}{4}$ is

**1)** $\int_{\sqrt{2}+1}^{\sqrt{2}-1}\frac{t}{(1+t^2)\sqrt{1-t^2}}dt$ **2)** $\int_{0}^{\sqrt{2}-1}\frac{4t}{(1+t^2)\sqrt{1-t^2}}dt$

**3)** $\int_{0}^{\sqrt{2}+1}\frac{4t}{(1+t^2)\sqrt{1-t^2}}dt$ **4)** $\int_{0}^{\sqrt{2}+1}\frac{t}{(1+t^2)\sqrt{1-t}}dt$

**17.** A water tank has the shape of an inverted circular cone with its axis vertical and vertex lowermost. Its semi-vertical angle is $\tan^{-1}(0.5)$. Water is poured into it at a constant rate of 5 cubic meter per hour. The rate at which the level of the water is rising at the instant when the depth of water in tank is 4m is (Take $\pi=\frac{22}{7}$)

**1)** 1m/h **2)** $\frac{30}{17}$m/h **3)** $\frac{70}{88}$m/h **4)** $\frac{35}{88}$m/h

**18.** Let $\alpha_1, \alpha_2, ...., \alpha_8$ be roots of the equation $1+z+z^2+...+z^8=0$. On throwing three dice simultaneously, sum of the numbers appearing on them is $n$. The probability such that $\sum_{i=1}^{8}(\alpha_i)^n = 8$ is $\frac{a}{b}$ (where $a$ and $b$ are co-prime) then the value $|7a-b|$ is:

**1)** 22 **2)** 16 **3)** 26 **4)** 17

**19.** Area bounded by $-8z^2 - 8\bar{z}^{-2} + 20z\bar{z} = 144$ is (where z is a complex number):

**1)** $\pi$ **2)** $6\pi$ **3)** $12\pi$ **4)** $4\pi$

**20.** $f(x)$ is a differentiable function satisfy the relationship $f^2(x)+f^2(y)+2(xy-1) = f^2(x+y)\ \forall x, y \in R$. Also $f(x)>0\ \forall\ x \in R$, and $f(\sqrt{2})=2$. then $f(\sqrt{7}) =$

**1)** 3 **2)** 4 **3)** 5 **4)** 7

## SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).

**Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.**

**21.** The mean weight of 9 items is 15. If one more item is added to the series, the mean becomes 16. The value of $10^{th}$ item is

**22.** Let $\{a_n\}$ and $\{b_n\}$ be two different sequences such that $a_{n+1} = 2 + a_n\ \forall\ n \in N,\ a_{10} = 21$ and $b_n = \frac{1}{a_n a_{n+2}} \forall n \in N$, then the value of $15\sum_{r=1}^{\infty} b_r$ is

**23.** A variable chord of the hyperbola $\frac{x^2}{4} - \frac{y^2}{8} = 1$, subtends a right angle at the centre of the hyperbola. If this chord touches a fixed circle which is concentric with the hyperbola and $r$ is radius of the circle, then $r^2$ is

**24.** If the integral $\int \frac{5\tan x dx}{\tan x - 2} = x + a\ell n|\sin x - 2\cos x| + C$ then '$a$' is equal to ($C$ is constant of integration)

**25.** The value of $\lim_{n\to\infty} \frac{\left(\lim_{x\to 0^-} \sum_{r=1}^{2n+1} [x^r]\right) + n + 3}{\ell n(1+n)^n - \ell n(n)^n}$; where [.] denotes greatest integers functions

**PHYSICS** **Max Marks: 100**

**SECTION-I (SINGLE CORRECT ANSWER TYPE)**

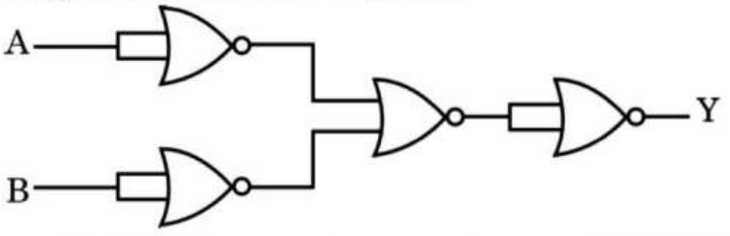
This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

**Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.**

**26.** A vernier calipers has a least count of 1 mm of its main scale. If 11 divisions of its main scale coincides with 12 divisions of vernier scale then its least count will be :-

**1)** $\frac{1}{12}$ mm **2)** $\frac{1}{11}$ mm **3)** $\frac{11}{12}$ mm **4)** $\frac{12}{11}$ mm

**27.** The truth table for digital circuit shown in figure is:




**1)**

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**2)**

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

**3)**

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**4)**

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**28.** Calculate the binding energy of an alpha particle (in MeV) (approx.) from the following data:-

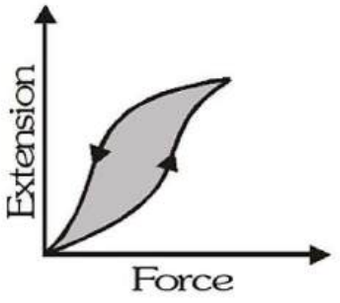
mass of H atom = 1.007862 u
mass of neutron = 1.008656 u
mass of He atom = 4.00206 u
Take 1 u = 931 MeV/$c^2$.

**1)** 25 **2)** 40 **3)** 29 **4)** 19

**29.** **Statement-1:** Two particle moving in the same direction do not lose all their energy in a completely inelastic collision.
**Statement-2:** In accordance with the principle of conservation of momentum, kinetic energy will not be zero once collision is over

**1)** Statement-1 is true, Statement-2 is false
**2)** Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1
**3)** Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1
**4)** Statement-1 is false, Statement-2 is true

**30.** The diagram shows a force-extension graph for a rubber band. Consider the following statements-
I. it will be easier to compress this rubber than expand it.
II. Rubber does not return to its original length after it is stretched.
III. The rubber band will get heated if it is stretched and released.
Which of these can deduced from the graph




**1)** III only **2)** II and III **3)** I and III **4)** I only

**31.** For a step-up transformer, the turns ratio is 3 and its efficiency is 0.75. The current flowing in the primary coil is 2A and the voltage applied to it is 100 V. Then the voltage and the current flowing in the secondary coil are _____ respectively:

**1)** 150 V, 1.5 A **2)** 300 V, 0.5 A **3)** 300 V, 1.5 A **4)** 150 V, 0.5 A

**32.** The intensity of light from a source is $\left(\frac{500}{\pi}\right)\text{W/m}^2$. Find the amplitude of electric field in this wave.

**1)** $\sqrt{3}\times10^{2}\,\text{N/C}$ **2)** $\sqrt{3}\times\ ^{2}$ **3)** $\frac{\sqrt{3}}{2}\times10^{2}\,\text{N/C}$ **4)** $2\sqrt{3}\times10^{1}\,\text{N/C}$

**33.** The armature of an electric drill motor has a resistance of $15\Omega$. When connected to a 120.0 V outlet, the motor rotates at its normal speed and develops a back emf of 108 V. What is the current when the motor runs at only half speed?

**1)** 0.3 A **2)** 4.4 A **3)** 1.2 A **4)** 2.0 A

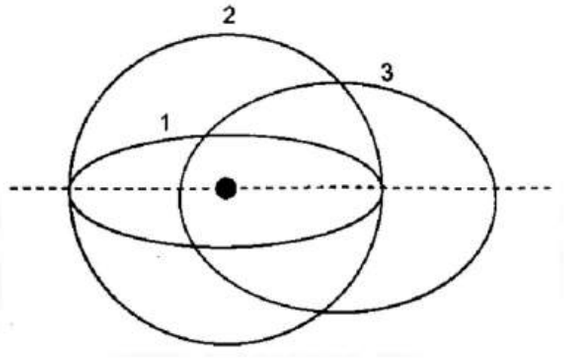
**34.** Light is incident on the surface of metallic sodium, whose work function is 2.3 eV. The maximum speed of the photoelectrons emitted by the surface is $1.2\times10^{6}$ m / s. What is the wavelength of the light?

**1)** 570 nm **2)** 710 nm **3)** 320 nm **4)** 194 nm

**35.** The number of possible natural oscillations of air column in a pipe closed at one end of length 85 cm whose frequencies lie below 1250 Hz are: (velocity of sound $= 340\ \text{ms}^{-1}$)

**1)** 4 **2)** 5 **3)** 7 **4)** 6

**36.** Statement-1: Three orbits are marked as 1, 2 and 3. These three orbits have same semi-major axis although their shapes (eccentricities) are different. The three identical satellites are orbiting in these three orbits, respectively. These three satellites have the same binding energy.




Statement-2: Total energy of a satellite depends on the semi-major axis of orbit according to the expression, $E = -\dfrac{GMm}{2a}$.

**1)** Statement-1 is true, Statement-2 is false

**2)** Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1

**3)** Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1

**4)** Statement-1 is false, Statement-2 is true

**37.** A travelling wave is described by the equation $y(x,t) = 0.05 \sin(8x - 4t)$m. The velocity of the wave is: - [all the quantities are in SI unit]

**1)** $4\,\text{ms}^{-1}$ **2)** $2\,\text{ms}^{-1}$ **3)** $0.5\,\text{ms}^{-1}$ **4)** $8\,\text{ms}^{-1}$

**38.** **Assertion**: For practical purposes, the earth is used as a reference at zero potential in electrical circuits.

**and**

**Reason**: The earth can be considered to be sphere of extremely large radius so for any finite value of charge its potential remain unchanged and hence can be used as reference.

**1)** Assertion and Reason are True; Reason is a correct explanation for Assertion

**2)** Assertion and Reason are True; Reason is not a correct explanation for Assertion

**3)** Assertion is True, Reason is False

**4)** Assertion is False, Reason is True

**39.** A solid non conducting sphere of radius R having variable volume charge density $d = \frac{Ar}{R}$ where $r$ is the distance from centre. If electric field at distance $\frac{R}{2}$ from the centre of charged sphere is $E = \frac{2R}{\epsilon_0}$ N/C. Value of $\frac{A}{16}$ will be

**1)** 2 **2)** 4 **3)** 6 **4)** 8

**40.** In Young's double slit experiment, the slits are 2mm apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000\text{Å}$ and $\lambda_2 = 10000\text{Å}$. At what minimum distance in mm from the common central bright fringe on the screen 2m from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the order?

**1)** 8 **2)** 6 **3)** 5 **4)** 3

41. **Assertion (A):** A ball is dropped from rest. A second ball is dropped from rest from the same height as the first, but 1s later. The distance between the balls when both are moving remains constants.

**Reasons (R):** When both the balls are falling freely, the acceleration of one ball with respect to another is zero.

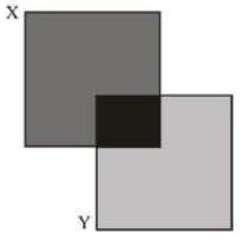
**1)** Assertion and Reason are True; Reason is a correct explanation for Assertion

**2)** Assertion and Reason are True; Reason is not a correct explanation for Assertion

**3)** Assertion is True, Reason is False

**4)** Assertion is False, Reason is True

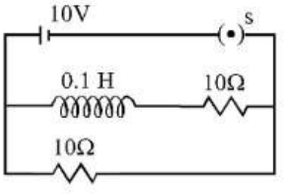
42. Two polarizers whose transmission axes are perpendicular to each other are placed so that they partially overlap. The polarizers in this arrangement are used to view the calm surface of a lake. To explain the light pattern in the diagram shown below, we need.




**1)** Both Brewster's law and Malus law **2)** Neither Brewster's law or Malus law

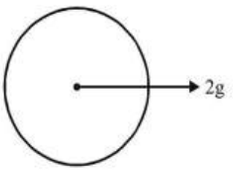
**3)** Brewster's law but not Malus law **4)** Malus law but not Brewster's law

43. In the adjoining circuit, initially the switch S is open. The switch 'S' is closed at t = 0. The difference between the maximum and minimum current that can flow through the battery is



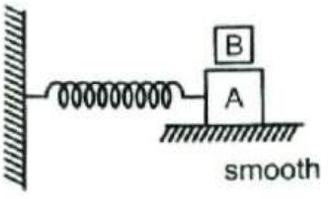

**1)** 2A **2)** 3A **3)** 1A **4)** 0.5 A

44. A hollow sphere of radius R is filled completely with an ideal liquid of density $\rho$. Sphere is moving horizontally with an acceleration 2g, where g is acceleration due to gravity in the sphere. If minimum pressure of liquid is $P_0$, then pressure at the centre of sphere is:-




**1)** $P_0 + \rho gR$ **2)** $P_0 + \rho gR\sqrt{2}$ **3)** $P_0 + \rho gR\sqrt{5}$ **4)** $P_0 + \frac{\rho gR}{\sqrt{5}}$

**45.** In the figure shown below block A is executing SHM on a smooth level ground. Another block *B* is kept gently on *A* in any of the positions mentioned in column-I. The block *B* sticks to *A*. Match with appropriate descriptions in column-II.



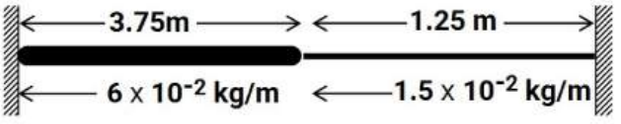

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| A) | Block *B* placed on the block *A* when *A* is at right extreme. | (P) | Momentum of $(A + B)$ can be assumed to be conserved at the time block *A* is placed on block *B*. |
| B) | Block *B* placed on the block *A* when *A* is at mean position. | (Q) | Mechanical energy is conserved. |
| C) | Block *B* placed on the block *A* when *A* is midway between extreme and mean. | (R) | Time period of SHM increases. |
| | | (S) | Amplitude of SHM decreases. |

**1)** (A) – P, (B) – Q, (C) – S
**2)** (A) – P, Q, R (B) – P, (C) – P
**3)** (A) – P, Q, R (B) – P, R, S (C) – P, R, S
**4)** (A) – P, Q (B) – P (C) – P, R, S

## SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).
**Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases**

**46.** Two strings have different lengths and linear densities, as the drawing shows. They are joined together and stretched so that the tension in each string is 216.0 N. The free ends of the joined string are fixed in place. Find the lowest frequency (in Hz) that permits standing waves in both strings with a node at the junction. The standing wave pattern in each string may have a different number of loops.

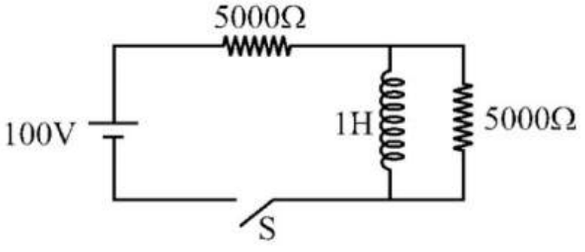



**47.** A particle of mass $m = 2$ kg is moving at 5 m/s in a given direction and is struck by an impulsive force F that deflects its direction of motion through $60^\circ$ and doubles the magnitude of its velocity. The same impulsive force F is applied to a mass of 5m at rest. What is the resulting kinetic energy of mass 5m (in J)?

**48.** The minimum energy of an electron necessary for ionization of an atom of hydrogen, is equal to $W_0$. Suppose that a hydrogen atom and helium atom both in ground state collide inelastically so that hydrogen atom is ionized. If the hydrogen was at rest and helium was moving with at least energy of $xW_0$, find the value of x.

**49.** In a coordinate system an electric field E and a magnetic field B exist in X-direction and particle of charge $q$ and mass m is projected with a velocity $v$ from origin along Y-direction. A target is located at point $(x_0, 0, 0)$. Find the magnitude of magnetic induction B (in Tesla) so that the particle will hit the target when it is crossing the X-axis third time. [Consider that $\pi^2 = 10, E = 1, x_0 = 1,\ m = 2, q = 10$ all quantities in SI Unit]

**50.** Find the value of instantaneous power (in W) supplied by battery at the moment after the switch is closed.



## CHEMISTRY

**Max Marks: 100**

### SECTION-I (SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

**Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.**

**51.** Given below are two statements :

**Statement I :** The limiting molar conductivity of KCl (strong electrolyte) is higher compared to that of $CH_3COOH$ (weak electrolyte).

**Statement II :** Molar conductivity increases with decrease in concentration of electrolyte.

In the light of the above statements, choose the most appropriate answer from the options given below:

**1)** Statement I is true but Statement II is false.

**2)** Statement I is false but Statement II is true.

**3)** Both Statement I and Statement II are true.

**4)** Both Statement I and Statement II are false.

**52.** Column-I and Column-II contains four entries each. Entries of Column-I are to be matched with some entries of Column-II. One or more than one entries of Column-I may have the matching with the same entries of Column-II

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| (A) | Very dilute solution of HCl | (P) | $O_2$ evolved at anode |
| (B) | Very dilute solution of NaCl | (Q) | $H_2$ evolved at cathode |
| (C) | Concentrated solution of NaCl | (R) | $Cl_2$ evolved at anode |
| (D) | Aqueous $AgNO_3$ | (S) | Ag deposition at cathode |

**1)** $A \rightarrow P,Q;B \rightarrow R,Q;C \rightarrow Q,R;D \rightarrow P,S$ **2)** $A \rightarrow P,Q;B \rightarrow P,Q;C \rightarrow Q,R;D \rightarrow P,Q$

**3)** $A \rightarrow Q,R;B \rightarrow R,Q;C \rightarrow Q,R;D \rightarrow P,S$ **4)** $A \rightarrow P,Q;B \rightarrow P,Q;C \rightarrow Q,R;D \rightarrow P,S$

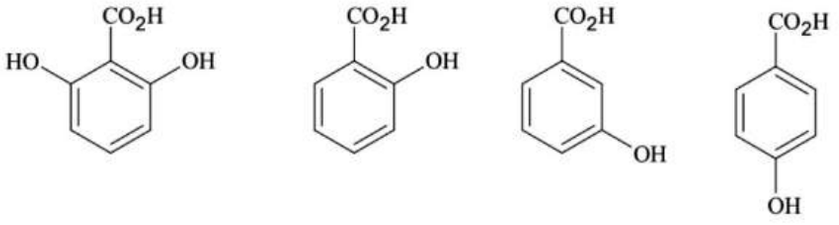
**53.** Which of the following organic compounds responds positively to both iodoform test and Fehling's test?

**1)** Ethanol **2)** Methanal **3)** Ethanal **4)** Propanone

**54.** Which one of the following bases is not present in DNA?

**1)** Cytosine **2)** Thymine **3)** Quinoline **4)** Adenine

**55.** The correct order of acidity for the following compounds is



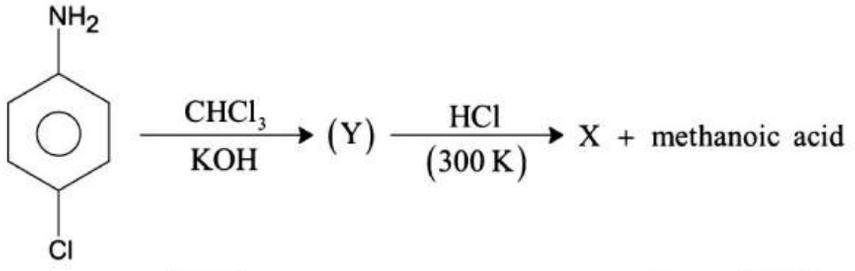
I II III IV

**1)** I > II > III > IV **2)** III > I > II > IV **3)** III > IV > II > I **4)** I > III > IV > II

**56.** Which of the following is a neutral oxide?

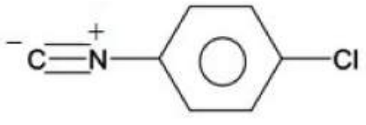
**1)** $Na_2O$ **2)** $N_2O$ **3)** $NaO_2$ **4)** $NO_2$

**57.** Identify X in the sequence given:

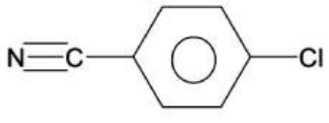


**1)**

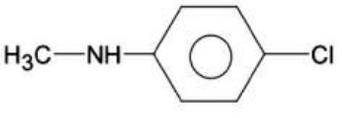
**2)**



**3)**



**4)**



**58.** The rate constant for the forward reaction $A(g) \rightarrow 2\ B(g)$ is $1.5\times10^{-3}\ s^{-1}$ at 100 K. If $10^{-5}$ moles of A and 100 moles of B are present in a 10 litre vessel at equilibrium then rate constant for the backward reaction at this temperature is

**1)** $1.50\times10^{4}\ L\ mol^{-1}\ s^{-1}$ **2)** $1.5\times10^{11}\ L\ mol^{-1}\ s^{-1}$

**3)** $1.5\times10^{10}\ L\ mol^{-1}\ s^{-1}$ **4)** $1.5\times10^{-11}\ L\ mol^{-1}\ s^{-1}$

**59.** **Assertion:** The bond length of C-O in phenol is shorter than bond length of alcohol; in general.

**Reason:** In phenol OH undergo resonance with benzene ring but in alcohol it not possible Statements, namely, Assertion (A) and Reason (R) For selecting the correct answer, use the following code:

**1)** Both Assertion (A) and Reason (R) are the true and Reason (R) is a correct explanation of Assertion (A).

**2)** Both Assertion (A) and Reason (R) are the true but Reason (R) is not a correct explanation of Assertion (A).

**3)** Assertion (A) is true and Reason (R) is false.

**4)** Assertion (A) is false and Reason (R) is true

**60.** From the given statements, incorrect statements are:

**I.** H.O.M.O. of dioxygen is $\pi^{*}2p$ [H.O.M.O = highest occupied Molecular orbital]

**II.** L.U.M.O. of dinitrogen is $\pi 2p$ [L.U.M.O = lowest unoccupied Molecular orbital]

**III.** Bond strength of $B_2 > F_2$

**1)** I, II and III **2)** II only **3)** II and III only **4)** III only

**61.** Which of the following process will produce $2^{\circ}$ amine?

**1)** Gabriel synthesis **2)** Hoffmann bromamide reaction

**3)** Reduction of carbylamines **4)** Reduction of nitro compounds

**62.** One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Amylose is water insoluble component.

Reason (R): Amylose is a long unbranched chain molecule with more than 200 $\alpha-D-(+)-$glucose units.

In the light of the above statements

**1)** Both (A) and (R) are correct and (R) is the correct explanation of (A)

**2)** Both (A) and (R) are correct and (R) is NOT the correct explanation of (A)

**3)** (A) is correct but (R) is not correct

**4)** (A) is not correct but (R) is correct

**63.** Given below are the two statements.

Statement-I: All $F-Cl-F$ angles are equal in $ClF_3$.

Statement-II: All $Cl-F$ bond lengths are equal in $ClF_3$.

In the light of the above statements, choose correct answer from the options given below:

**1)** Both Statement-I and Statement-II are true

**2)** Both Statement-I and Statement-II are false

**3)** Statement-I is true but Statement-II is false

**4)** Statement-I is false but Statement-II is true.

**64.** Consider the expansion of one mole of an ideal gas from an initial state to a final state, with $\Delta S$ representing the entropy change in the process. The correct statement is:

**1)** If the process is carried out reversibly, the value of $\Delta S$ will be higher in comparison to its irreversible counterpart

**2)** If the process is adiabatic, the value of $\Delta S$ is always zero, irrespective of whether the process is carried out reversibly or irreversibly

**3)** If the process is isothermal, there will not be any heat exchange with the surrounding since the temperatures of the system and the surrounding are equal

**4)** If the process is isothermal and the final volume is double of the initial volume, the value of $\Delta S$ will be independent of the temperature

**65.** Choose the **CORRECT** statements?

a) Alcohols $(ROH)$ are weaker acids than benzene sulphonic acid.

b) Water is a better proton donor than ethanol.

c) $\overset{\ominus}{N}H_2$ ion is a better proton acceptor than $\overset{\ominus}{O}H$ ion.

d) Sodium ethoxide is a stronger base than sodium hydroxide

**1)** a, b and c only **2)** b and c only **3)** b, c and d only **4)** a, b, c and d only

**66.** The electronic configurations of bivalent europium and trivalent cerium are (atomic number : $Xe = 54, Ce = 58, Eu = 63$)

**1)** $[Xe]4f^2$ and $[Xe]4f^7$ **2)** $[Xe]4f^7$ and $[Xe]4f^1$

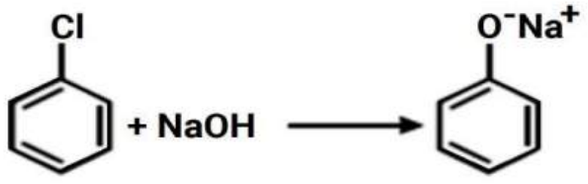
**3)** $[Xe]4f^7 6s^2$ and $[Xe]4f^2 6s^2$ **4)** $[Xe]4f^4$ and $[Xe]4f^9$

**67.** A liquid mixture contain 10 moles of $A(P_A^\circ = 200\,mmHg)$ and 10 moles of $B(P_B^\circ = 100 mmHg)$. The vapour pressure over liquid mixture is 160 mm Hg. Which is correct statement?

**1)** $\Delta G_{mix} = +ve$ **2)** $\Delta V_{mix} = -ve$

**3)** $\Delta S_{surrounding} = +ve$ **4)** $\Delta S_{surrounding} = -ve$

**68.** The above reaction requires which of the following reaction conditions?




**1)** 623 K, Cu, 300 atm **2)** 573 K, 300 atm

**3)** 573 K, Cu, 300 atm **4)** 623 K, 300 atm

**69.** Consider following orders against the mentioned property:

I: $Mg < Si < Al < S < P$ ($2^{nd}$ ionisation potential )

II: $Na_2O < MgO < Al_2O_3 < P_2O_5$ (Acidic strength)

III: $C < N < O < F$ (Electron affinity)

The incorrect order(s) is/are

**1)** Only I **2)** Only III **3)** Only I and III **4)** I, II and III

**70.** 100 mL of 0.5M $Na_3PO_4$ aqueous solution is mixed with 80 mL of 1.25 M HCl solution. The pH of the final solution is (Given: $K_{a_1}$, $K_{a_2}$ and $K_{a_3}$ of $H_3PO_4$ are $10^{-3}$,$10^{-5}$ and $10^{-7}$ respectively)

**1)** 6 **2)** 4 **3)** 3.5 **4)** 4.7

## SECTION-II (NUMERICAL VALUE TYPE)

This section contains **5 Numerical Value Type Questions.** The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **Nearest Integer** value (Example i,e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11**).

**Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases**

**71.** From the following data, calculate the standard enthalpy change for the combustion of cyclopropane at 298 K: The standard enthalpy of formation of $CO_2(g), H_2O(\ell)$ and propene(g) are $-393.5$, $-285.8$ and $20.42\,kJ\,mol^{-1}$ respectively.

The standard enthalpy of isomerization of cyclopropane to propene is $-33.0\,kJ\,mol^{-1}$.

Report your answer by rounding off to nearest integer [magnitude only]

**72.** Tollen's test is used for detection of aldehydic group in organic compounds like glucose. The test is as follows: An aqueous solution of $AgNO_3$ is added to an aqueous solution of glucose in a test tube. When concentrated ammonia is added, silver is deposited. This is a redox reaction as $Ag^+$ is reduced to Ag and glucose is oxidized to gluconic acid. The following half-cell reactions and the standard half-cell potentials are given :

$Ag^+ + e^- \rightarrow Ag \qquad E^0_{red} = 0.8\ V$

$C_6H_{12}O_6 + H_2O \rightarrow C_6H_{12}O_7 + 2H^+ + 2e^- \qquad E^0_{ox} = -0.05\ V$

$[Ag(NH_3)_2]^+ + e^- \rightarrow Ag + 2NH_3 \qquad E^0_{red} = 0.37\ V$

Given : $2.303RT/F = 0.0592\ V, F/RT = 38.90\ V^{-1}$ at 298 K

Then find the value of the logarithm of the equilibrium constant (ln K) of the following reaction

$$C_6H_{12}O_6 + 2Ag^+ + H_2O \rightleftharpoons C_6H_{12}O_7 + 2H^+ + 2Ag\downarrow$$

[Report your answer by rounding off to nearest integer value]

**73.** Number of unpaired electrons in $Mn^{+7} = a$

Number of d-subshell electrons in $Cr = b$

Number of f-subshell electrons in Hf (Atomic no. = 72) = c.

Find the value of $c - b + a$.

**74.** How many mono cyclic structures are possible for $C_4H_6$ [Consider structural isomers only]

**75.** The number of deBroglie waves made by an electron in an orbit having lowest principal quantum number that contains f sub level are

# ANSWER KEY

## MATHEMATICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | **3** | 2 | **3** | 3 | **3** | 4 | **3** | 5 | **2** |
| 6 | **1** | 7 | **3** | 8 | **3** | 9 | **3** | 10 | **3** |
| 11 | **4** | 12 | **3** | 13 | **3** | 14 | **2** | 15 | **1** |
| 16 | **2** | 17 | **4** | 18 | **4** | 19 | **3** | 20 | **1** |
| 21 | **25** | 22 | **2** | 23 | **8** | 24 | **2** | 25 | **2** |

## PHYSICS

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 26 | **1** | 27 | **3** | 28 | **3** | 29 | **2** | 30 | **1** |
| 31 | **2** | 32 | **2** | 33 | **2** | 34 | **4** | 35 | **4** |
| 36 | **2** | 37 | **3** | 38 | **1** | 39 | **1** | 40 | **2** |
| 41 | **4** | 42 | **1** | 43 | **3** | 44 | **3** | 45 | **3** |
| 49 | **48** | 47 | **15** | 48 | **5** | 49 | **6** | 50 | **1** |

## CHEMISTRY

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 51 | **2** | 52 | **4** | 53 | **3** | 54 | **3** | 55 | **1** |
| 56 | **2** | 57 | **1** | 58 | **4** | 59 | **1** | 60 | **2** |
| 61 | **3** | 62 | **4** | 63 | **2** | 64 | **4** | 65 | **4** |
| 66 | **2** | 67 | **4** | 68 | **4** | 69 | **3** | 70 | **2** |
| 71 | **2091** | 72 | **58** | 73 | **9** | 74 | **4** | 75 | **4** |

# SOLUTION
# MATHEMATICS

1. Sol. Let eccentricity of conjugate hyperbola be $e'$

$$\therefore \frac{1}{e^2}+\frac{1}{e'^2}=1 \Rightarrow \frac{1}{e'^2}=1-\frac{1}{e^2} \Rightarrow e'=\frac{e}{\sqrt{e^2-1}} \quad \therefore f(e)=\frac{e}{\sqrt{e^2-1}}$$

$$\text{and } f(f(e))=\frac{f(e)}{\sqrt{f^2(e)-1}}=\frac{\frac{e}{\sqrt{e^2-1}}}{\sqrt{\frac{e^2}{e^2-1}-1}}=e$$

$$\therefore \text{ Given integral} = \int\left(\frac{e}{\sqrt{e^2-1}}+e\right)de=\left(\sqrt{^2-1}+\frac{e^2}{2}\right)$$

$$g(e)=\sqrt{e^2-1}+\frac{e^2}{2}+C \quad g\left(\sqrt{2}\right)=1+1+C \quad \Rightarrow C=0 \qquad g(e) \quad \sqrt{^2-1} \quad \frac{e^2}{2}$$

2. Sol. Let $x=\tan\theta$ $\qquad \int_0^{\pi/4}\frac{\theta}{1+\tan\theta}\sec^2\theta\, d\theta$

$$=\theta\log_e(1+\tan)I_0^{\pi/4}-\int_0^{\pi/4}\log_e(1+\tan\theta)d\theta \qquad =\frac{\pi}{4}\log_e 2-I$$

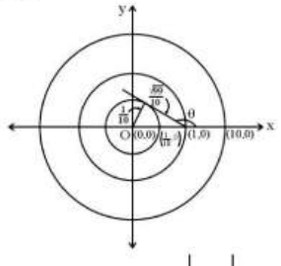
$$I=\int_0^{\pi/4}\log_e(1+\tan\theta)d\theta\ldots.(1)$$

$$I=\int_0^{\pi/4}\log_e\left(1+\tan\left(\frac{\pi}{4}-\theta\right)\right)d\theta$$

$$I=\int_0^{\pi/4}\log_e\left(\frac{2}{1+\tan\theta}\right)d\theta$$

$$\text{By}(1)+(2) \Rightarrow 2I=\int_0^{\pi/4}\log_e 2\, d\theta=\frac{\pi}{4}\log_e 2 \Rightarrow I=\frac{\pi}{8}\log_e 2$$

3. Sol.




$$\text{Put}\frac{z_1}{z_2}=z \quad \therefore \left|\frac{z_1}{z_2}\right|=|z| \Rightarrow |z|=\frac{1}{10}$$

$$\text{Also, } \theta=\arg\left(\frac{z_1}{z_2}-1\right)=\arg(z-1) \qquad \therefore \tan^2\theta\Big]_{\text{max.}}=\frac{1/100}{99/100}=\frac{1}{99}$$

4. Sol. $n(S)=12^6$

Now, any two months can be chosen in ${}^{12}C_2$ ways. The six birthday can fall in these two months in $2^6$ ways. Out of these $2^6$ ways there are two ways when all the six birthdays fall in one month so favourable number of ways in ${}^{12}C_2 \times \left(2^6 - 2\right)$.

Hence required probability is

$$= \frac{{}^{12}C_2 \times \left(2^6 - 2\right)}{12^6} = \frac{12 \times 11 \times \left(2^6 - 2\right)}{2 \times 12^6} = \frac{341}{12^5}$$

5. Ans. B

Sol. Put $\begin{vmatrix} (1-\lambda) & 3 & -4 \\ 1 & -(3+\lambda) & 5 \\ 3 & 1 & -\lambda \end{vmatrix} = 0$

$\Rightarrow \lambda(\lambda+1)^2 = 0 \Rightarrow \lambda = -1, 0$

6. Sol. (A) As line is parallel to the plane, the point $(4,2,2k)$ should lie in the given plane

$\therefore 2(4) - 4(2) + 2k = 3 \Rightarrow k = \frac{3}{2}$

(B) Any point on given lines are $(2\lambda+1, 3\lambda-1, 4\lambda+1)$ and $(\mu+3, 2\mu+k, \mu)$ respectively.

By equating the corresponding coordinates $\Rightarrow k = \frac{9}{2}$

(C) Equation of plane is $\frac{x}{a} + \frac{y}{a} + \frac{z}{a} = 1$ satisfy it by given point $\Rightarrow \frac{1}{a} + \frac{1}{a} + \frac{1}{a} = 1 \Rightarrow a = 3$

hence $A(3,0,0), B(0,3,0), C(0,0,3) \Rightarrow$ volume of tetrahedron $= \frac{1}{6}\begin{vmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{vmatrix} = \frac{9}{2}$ cubic units

(D) The equation of plane is $a(x-1) + b(y+2) + c(z-1) = 0$ & $2a - 2b + c = 0$

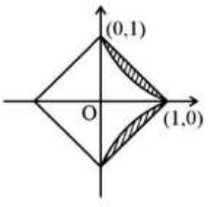
$a - b + 2c = 0 \quad \Rightarrow \frac{a}{1} = \frac{b}{1} = \frac{c}{0}$ hence equation of plane is $x + y + 1 = 0$

7. Sol. Let $\vec{a} \wedge \vec{b} = \theta$, Now $\vec{x} = \vec{a} - (\vec{a} \cdot \vec{b})\vec{b} \quad \Rightarrow |\vec{x}|^2 = \vec{a}^2 + (\vec{a} \cdot \vec{b})^2 \, b^2 - 2(\vec{a} \cdot \vec{b})^2$

$\Rightarrow |\vec{x}^2 = 1 + \cos^2\theta - 2\cos^2\theta \quad \Rightarrow |\vec{x}| = \sin\theta$, Also $\because \vec{y} = \vec{a} \times \vec{b} \Rightarrow |\vec{y}| = |\vec{a} \times \vec{b}| = \sin\theta$

$\therefore |\vec{x}| = |\vec{y}|$ Also, $\vec{x} \cdot \vec{b} = \vec{a} \cdot \vec{b} - (\vec{a} \cdot \vec{b})\vec{b}^2 = 0 \quad \therefore |\vec{x} \cdot \vec{b}| = 0$

8. $\sqrt{x} + \sqrt{|y|} = 1$. Above curve is symmetric about $x$-axis $\sqrt{|y|} = 1 - \sqrt{x}$ and $\sqrt{x} = 1 - \sqrt{|y}$



$\Rightarrow x>0,\ y=0\ \sqrt{y}=1=1-\sqrt{x}\quad \frac{1}{2\sqrt{y}}\frac{dy}{dx}=-\frac{1}{2\sqrt{x}}\quad \frac{dy}{dx}=-\sqrt{\frac{y}{x}}<0,$

Function is decreasing required area $=2\int_0^1\left(2\sqrt{x}-2x\right)=\frac{2}{3}$

9. Sol. On solving $\frac{\pi}{2}-\sin^{-1}\left(\frac{2\times 4x}{1+(4x)^2}\right)\quad =-\frac{\pi}{2}+2\tan^{-1}(4x)$

$\Rightarrow 2\tan^{-1}4x=\pi-\sin^{-1}\left(\frac{2(4x)}{1+(4x)^2}\right)\quad 4x\geq 1;\ x\geq\frac{1}{4}$

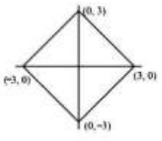
10. Sol. Let $p(h,k)$ be the point of contact $\quad 2y\frac{dy}{dx}=4a\ \&\ 2x=4a\frac{dy}{dx}$

both $\frac{dy}{dx}$ are same $\quad \Rightarrow\frac{4a}{2y}=\frac{2x}{4a}\Rightarrow xy=4a^2$

11. Sol. $A\cdot AdjA=|A|I_n\quad (AdjA)(AdjAdjA)=|AdjA|In=|A|^{n-1}\ I_n$

$(adjadjA)(adjadjadjA)=|A|^{(n-1)^2}\ I_n\ \Rightarrow (adjadj.....A)(AdjAdjAdj...A]=|A|^{(n-1)^{(n-1)}}\cdot I_n$

12. Sol. favorable points $\rightarrow$ (1, 1) (1, 2) (2, 1) Prob. $=\frac{3}{26}=\frac{1}{12}$



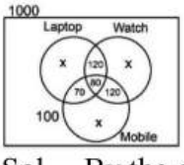

13. Let the plane be $(x+y+z-1)+\lambda(2x+3y+4z-5)=0$

$\Rightarrow(2\lambda+1)x+(3\lambda+1)y+(4\lambda+1)$

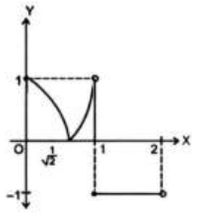
$z-(5\lambda+1)=0\perp$ to the plane $x-y+z=0\quad \Rightarrow\lambda=-\frac{1}{3}$

$\Rightarrow$ the required plane is $x-z+2=0$

14. Sol. $3x+120+120+70+80=900\quad 3x=510,\quad x=170$




15. Sol. By the graph of $y=f(x)$ clearly, $f(x)$, is discontinuous at $x=1$ and $f(x)$ is non – differentiable at $x=\frac{1}{\sqrt{2}}$ and $x=1$



16. Sol. Area $=\int_0^{\frac{\pi}{4}} \frac{\sqrt{1+\sin x}-\sqrt{1-\sin x}}{\sqrt{\cos x}}dx$ $=\int_0^{\frac{\pi}{4}} \frac{2\sin\frac{x}{2}dx}{\sqrt{\cos^2\frac{x}{2}-\sin^2\frac{x}{2}}}$

By putting $\tan\frac{x}{2}=t$ integral will become $\int_0^{\sqrt{2}-1} \frac{4t}{\left(1+t^2\right)\sqrt{1-t^2}}dt$

17. Sol. $r=\frac{h}{2}\Rightarrow v=\frac{1}{3}\pi r^2 h=\frac{\pi h^3}{12}$

$\frac{dv}{dt}=\frac{\pi}{4}h^2\frac{dt}{dt}=5\Rightarrow \left.\frac{dt}{dt}\right]_{h=4}=\frac{20}{\pi}\times\frac{1}{16}=\frac{35}{88}$ m / h

18. Sol. 'n' should be multiple of 9 for favourable event.

So, $x_1+x_2+x_3=9$ or 18 If $x_1+x_2+x_3=9, 1\le x_i\le 6$

No. of solution of $(1)=$ coefficient of $x^9$ in

$\left(x+x^2+.....+x^6\right)^3=\left[x\left(1-x^6\right)\right]^3(1-x)^{-3}$

$=$ coefficient of $x^6$ in $\left(1-3x^6\right)(1-x)^{-3}$ $={}^8C_6+(-3)\times 1=25$

And, there is only one solution of $x_1+x_2+x_3=18, 1\le x_i\le 6$

Hence, $n(E)=26$, Also $n(S)=6^3$ $\Rightarrow P(E)=\frac{13}{108}$

19. Sol. Let $z=x+$ iy $-8\left((x+iy)^2+(x-iy)^2\right)+20\left(x^2+y^2\right)=144$

$-8\left(2\left(x^2-y^2\right)\right)+20\left(x^2+y^2\right)=144$

$4x^2+36y^2=144$ , $\frac{x^2}{36}+\frac{y^2}{4}=1$ , $a=6, b=2$. Area $=\pi ab=12\pi$

20. Sol. put $x=0$ and $y=0\Rightarrow f^2(0)=2$

$f'(x)=\text{Limit}_{h\to 0}\frac{f(x+h)-f(x)}{h}=\text{Limit}_{h\to 0}\frac{f^2(x+h)-f^2(x)}{\left[f(x+h)+f(x)\right]\cdot h}$

$=\frac{1}{2f(x)}\text{Limit}_{h\to 0}\frac{f^2(h)+2(xh-1)}{h}=\frac{1}{2f(x)}\text{Limit}_{h\to 0}\left[\frac{2xh}{h}+\frac{f^2(h)-2}{h}\right]$

$=\frac{1}{2f(x)}\left[2x+\text{Limit}_{h\to 0}\frac{f^2(h)-f^2(0)}{h}\right]=\frac{1}{2f(x)}\left[2x+\text{Limit}_{h\to 0}\frac{f(h)-f(0)}{h}\cdot\left(f(h)+f(0)\right)\right]$

$f'(x)=\frac{1}{2f(x)}\left[x^2+f(0)\cdot f'(0)\right]$ $\therefore\ f(x)\cdot f'(x)=x+f(0)\cdot f'(0)$

$\Rightarrow f(x)\cdot f'(x)=x+\lambda$, where $\lambda=f(0)\cdot f'(0)$

integrating both sides $\therefore \frac{f^2(x)}{2}=\frac{x^2}{2}+\lambda x+C$

$f^2(x)=x^2+2\lambda x+C$ at $x=0, f^2(0)=2\Rightarrow C=2$

$x=\sqrt{\ } f^2(\sqrt{2})= \Rightarrow \lambda= \therefore f^2(x)=x^2+2 \Rightarrow f(x)=\sqrt{x^2+2}(f(x)>0)$

21. Sol. Let $x_1, x_2, x_3 \ldots x_4$ are 9 items then their mean $\Rightarrow \frac{x_1+x_2+x_3+\ldots+x_9}{9}=15$

$\therefore \sum_{i=1}^{9} x_i=135$ if one more item $x_{10}$ is added then $\sum_{i=1}^{10} x_i=135+x_{10}$

$\therefore$ mean $\bar{x}=\frac{135+x_{10}}{10}=16$ $\therefore x_{10}=160-135=25$

22. Sol. $a_1, a_2, a_3, \ldots$ are in A.P

$d=2, a_{10}=21\Rightarrow a_1=3, a_n=2n+1$ $\sum_{r=1}^{\infty} b_r=\sum_{n=1}^{\infty}\frac{1}{(2n+1)(2n+5)}$

$=\frac{1}{4}\sum_{n=1}^{\infty}\left(\frac{1}{2n+1}-\frac{1}{2n+5}\right)=\frac{1}{4}\left[\frac{1}{3}+\frac{1}{5}\right]=\frac{2}{15}$

23. Sol. Let the variable chord be $x\cos\alpha+y\sin\alpha=p$ which intersect the hyperbola in A and B the joint equation of OA and OB is $\frac{x^2}{4}-\frac{y^2}{8}=\left(\frac{x\cos\alpha+y\sin\alpha}{p}\right)^2$

$\Rightarrow\left(\frac{1}{4}-\frac{\cos^2\alpha}{p^2}\right)x^2-\left(\frac{1}{8}+\frac{\sin^2\alpha}{p^2}\right)y^2-\left(\frac{2\sin\alpha\cos\alpha}{p^2}\right)x\cdot y=0$

$\Rightarrow\frac{1}{4}-\frac{\cos^2\alpha}{p^2}-\frac{1}{8}-\frac{\sin^2\alpha}{p^2}=0\Rightarrow p^2=8$

The variable line touches the fixed circle, thus perpendicular distance of $(0,0)=$ Radius

$r=\left|\frac{0+0-p}{\sqrt{\cos^2\alpha+\sin^2\alpha}}\right|$ $r=|p|=\sqrt{8}$ $\therefore$ equation of the circle is $x^2+y^2=8$.

24. $\int\frac{5\sin x dx}{\sin x-2\cos x}=\int dx+2\int\frac{\cos x+2\sin x}{\sin x-2\cos x}$ $dx=x+2\ln|\sin x-2\cos x|+C$

25. Sol. $\lim_{x\to 0^-}\sum_{r=1}^{2n+1}\left[x^r\right]=\lim_{x\to 0^-}[x]+\left[x^2\right]+\left[x^3\right]+\ldots+\left[x^{2n+1}\right]$

$=(-1)+0+(-1)+\ldots+0+(-1)=(-1)(n+1)=-n-1$

$\Rightarrow L=\lim_{n\to\infty}\frac{-n-1+n+3}{n\ln\left(\frac{1+n}{n}\right)}=\lim_{n\to\infty}\frac{2\left(\frac{1}{n}\right)}{\ln\left(1+\frac{1}{n}\right)}$ $\Rightarrow\frac{1}{n}=t\Rightarrow L=\lim_{t\to 0}\frac{2t}{ln(1+t)}=2$

26. Sol. Least count = 1MSD − 1VSD

27. Sol. $Y = (\overline{\overline{A} + \overline{B}}) = \overline{A.B}$ This is NAND gate

28. Sol. $E_b = (2m_H + 2m_n - m_\alpha)c^2 \qquad = 28.8\ MeV = 29MeV$

29. Sol. Conceptual

30. Sol. Elastic hysteresis loss

31. Sol. $V_s = 300 \qquad V_p i_p \times \frac{3}{4} = V_s i_s$

32. Sol. $\frac{1}{2} \in_0 E_0^2 c = I$

33. Sol. At half speed, back emf reduced to half $e = \frac{Bwr^2}{2}$

So $i = \frac{120 - 54}{12} = \frac{66}{15} = 4.4$

34. Sol. $\frac{hc}{\lambda} = KE_{\max} = \varphi$

35. Sol. $f = n.\frac{V}{4\ell} \qquad n = 1, 3, 5.....$

Possible frequencies are 100, 300, 500, 700, 900, 1100

36. Sol. In all three orbits, length of semi major axis is same

37. Sol. $V = \frac{\omega}{k}$

38. Sol. For any value of finite value of charge, $\frac{kQ}{R} \to 0$ as radius R is very large

39. Sol. According to Gauss law

$\oint \vec{E}.d\vec{s} = \frac{q_{in}}{\in_0} \qquad q_{in} = \int_0^{R/2} d \cdot 4\pi r^2 dr, \qquad$ Solving $\frac{A}{16} = 2$

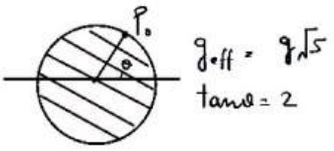
40. Sol. $m\lambda_1 = m\lambda_2 \qquad m = 5$ and $n = 6 \qquad$ So $y = \frac{5D\lambda_1}{d}$

41. Sol. Since relative acceleration is zero so relative velocity will remain constant and hence separation keeps on increasing

42. Sol. Based on theory

43. Sol. $i_{\max}$ (After long time) $= \frac{10V}{5\Omega} = 2A \qquad i_{\min}$ (at t=0) $= \frac{10}{10} = 1A$

44. Sol.



45. Sol. In all situations of column (I), linear momentum will be conserved as no impulsive force acts during placement. Time period will definitely increase mechanical energy will be conserved only in situation (A) as no slipping, in other situations mechanical energy will decrease and so as amplitude.

46. Sol. Suppose $m$ and $n$ loops respectively in the two strings respectively

$$\frac{m}{2l_1}\sqrt{\frac{T}{\mu_1}}=\frac{n}{2l_2}\sqrt{\frac{T}{\mu_2}}$$

Solving, $\frac{m}{n}=\frac{6}{1}$

Now $f=\frac{6}{2l_2}\sqrt{\frac{216}{6\times10^{-2}}}$

$=48\text{Hz}$

47. Sol. $F\Delta t=|\Delta|\vec{p}|=mv\sqrt{3}$

$=10\sqrt{3}\,\text{kg m/s}$

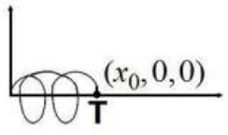
Now $F\Delta t=5mV_0$

$K=\frac{1}{2}5mV_0^2=15J$

48. Sol. Possible loss $=\frac{1}{2}\frac{4m}{5}V^2=W_0$

$KE_{He}=\frac{1}{2}4mV^2=5W_0$

49. Sol.




$\vec{E}\parallel\vec{B}$

Motion will be helical with increasing pitch, particle should hit the target in third round

$x_0=\frac{1}{2}\frac{qE}{m}(3T)^2$

$\Rightarrow B=6T$

50. Sol. $P=\frac{V^2}{R_{eq}}$ at $t=0$ (Switch closed)

$=\frac{(100)^2}{10000}=1W$

# CHEMISTRY

51.

| Ion | $H^+$ | $K^+$ | $Cl^-$ | $CH_3COO$ |
|---|---|---|---|---|
| $\Lambda^\infty_{m}$ Sm²/mole | 349.8 | 73.5 | 76.3 | 40.9 |

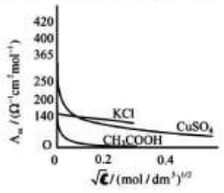
So, $\Lambda^\infty_{mCH,COOH} = \Lambda^\infty_{m(H^+)} + \Lambda_{mCH_3COO^-} = 349.8 + 40.9$

$= 390.7 Scm^2$ / mole $\quad \Lambda^\infty_{mKCl} = \Lambda^\infty_{m(K')} + \Lambda^\infty_{m(Cl^\ominus)}$

$= 73.5 + 76.3 \quad = 149.3 Scm^2$ / mole

So statement-I is wrong or False.

As the concentration decreases, the dilution increases which increases the degree of dissociation, thus increasing the no. of ions, which increases the molar conductance




52. Sol. Electrolysis of dilute/concentrated of NaCl : Water is reduced at cathode to give hydrogen gas and chloride ion is oxidized at anode (due to over potential of oxygen) to give chlorine gas.

Electrolysis of dil. $HCl: H^+$ is reduced at cathode and chloride ion is oxidised at anode (due to over potential of oxygen) to give chlorine gas.

Electrolysis of concentrated of $AgNO_3$ : Silver ion is reduced at cathode to deposit silver and water is oxidized at anode to give oxygen gas.

53. Sol. The compound which contains $-COCH_3$ group in its structure, give positive iodoform test and the compound which contains $-$ CHO group give positive Fehling test. In ethanol, $CH_3CHO$ both the groups are present, hence it responds to both iodoform test and Fehling's test. Iodoform test

$CH_3CHO + I_2 + NaOH \rightarrow CHI_3 + NaI + H_2O$

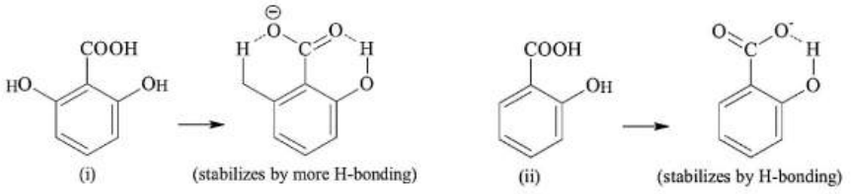
Fehling's test

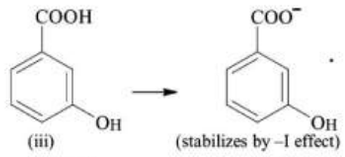
$CH_3CHO + Cu(OH_2)_2 \rightarrow CH_3COOH + Cu_2O\downarrow + 2H_2O$

(red ppt.)

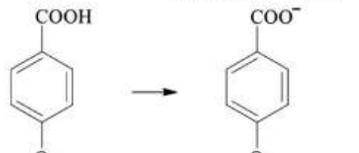
54. Sol. Factual

55. Sol.





(iii) (stabilizes by –I effect)

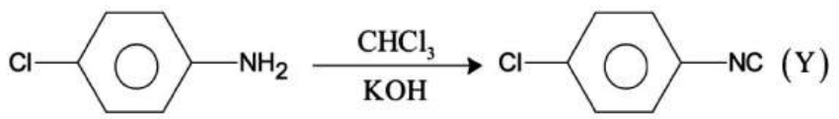


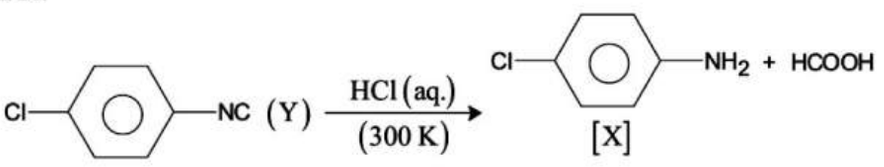
(iv) (destabilizes by +M effect)

$\therefore$ Acidity order is I > II > III > IV

56. Sol. $N_2O$, NO and CO are neutral oxides.

57. Sol.




58. Sol. $A \rightleftharpoons 2B \quad K_c = \dfrac{[B]^2}{[A]}$

$$\frac{K_f}{K_b} = \frac{(100/10)^2}{(10^{-5}/10)} \Rightarrow \frac{1.5\times10^{-3}}{K_b} = \frac{100}{\left(10^{-6}\right)} \Rightarrow K_b = 1.5\times10^{-11}$$

59. Sol. Factual

60. Sol. H.O.M.O of $O_2$ is $\pi^*2p$ and L.U.M.O of $N_2$ is $\pi^*2p$.
Bond strength of $B_2 > F_2$. Lower bond strength of $F_2$ is due to repulsion between lone pairs of the bonded F atoms.

61. Sol. Reduction of RNC will produce $R-NH-CH_3$.

62. Sol. Factual

63. Sol. $ClF_3$ have Trigonal bipyramidal geometry and T-shape. One short equatorial bond and two long axial bonds and $F_a - Cl - F_a$ bond angle of 175°.

64. Sol. For isothermal $\Delta S_{sys} = nR\ell n\dfrac{V_f}{V_i}$.

65. Sol. Factual

66. Sol. $Eu^{2+}:[Xe]4f^7; Ce^{3+}:[Xe]4f^1$

67. Sol. $P_{solution} = 160$
Solution have positive deviation from Raoult's law.
$P_{total} = 200\times0.5 + 100 + 0.5 = 150$

$\Delta G_{mix} < 0 \quad \Delta V_{mix} > 0 \quad \Delta H_{mix} > 0$

$\Delta S_{surr} < 0$

68. Sol. DOW's reaction, see NCERT

69. Sol. Hint: On moving left to right acidic strength of oxide increases

Sol.: Correct order of 2nd I.P. : $Mg < Si < Al < P < S$

Correct order of electron affinity: $N < C < O < F$

70. Sol. Hint: m. moles of $Na_3PO_4 = 50$

M moles of $HCl = 100$

Sol.: Final solution will have $NaH_2PO_4$ (amphoteric salt)

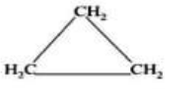
$$\therefore pH = \frac{pKa_1 + pK_{a_2}}{2} = 4$$

71. Sol. $CH_3CH = CH_2(g) + \frac{9}{2}O_2(g) \rightarrow 3CO_2(g) + 3H_2O(\ell)$

$$\Delta_c H^{\Theta}_{(Propene)} = \left[3\Delta_f H^{\Theta}_{(CO_2)} + 3\Delta_f H^{\Theta}_{(H_2O)}\right] - \left[\Delta_f H^{\Theta}_{(Propene)} + \frac{9}{2}\Delta_f H^{\Theta}_{O_2}\right]$$

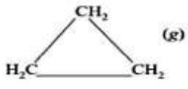
$= 3(-393.5) + 3(-285.8) - (20.42) = -2058.32 \text{ kJ mol}^{-1}$

To the above reaction, if we add the reaction:



$(g) \longrightarrow \underset{\text{Propene}}{CH_3CH = CH_2(g)} \qquad \Delta_{isomerization} H^{\Theta} = -33.0 \text{ kJ mol}^{-1}$

we get :



$(g) + \frac{9}{2}O_2(g) \longrightarrow 3CO_2(g) + 3H_2O(\ell)$

Hence, $\Delta_c H^{\Theta}_{(cyclopropane)} = (-2058.32 - 33.0)\text{kJmol}^{-1} = -2091.32 \text{ kJ mol}^{-1}$

72. Sol. Create Cell as:

Cathode : $Ag^+ + e^- \longrightarrow Ag \qquad E^0_{reduction} = 0.8V$

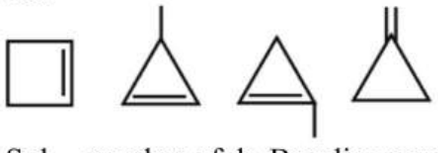
Anode: $\dfrac{C_6H_{12}O_6 + H_2O \longrightarrow C_6H_{12}O_7 + 2H^+ + 2e^-}{2Ag^+ + C_6H_{12}O_6 + H_2O \longrightarrow 2Ag + C_6H_{12}O_7 + 2H^+} \qquad E^0_{reduction} = 0.0.5V$

When the reaction reaches equilibrium, $Q_{cell} = K_{eq}$ and $E_{cell} =$

Using: $\ell nk_{eq} = E^0_{cell}.n_{cell}.\dfrac{E}{RT} = 0.75 \times 2 \times 38.90 = 58.35 \quad (E^0_{cell} = 0.8 - 0.05 = 0.75V)$

73. Sol. $a = 0, b = 5, c = 14$

74. Sol.



75. Sol. number of de-Broglie waves = principal quantum number of the orbit